

WHAT IS CLAIMED IS:

1. An illumination optical apparatus comprising:
 a light supply means for supplying a beam;
 a light-source-image forming means for forming a
 5 plurality of light source images which are substantially
 linearly arranged in at least one line, based on the
 beam from said light supply means;

an optical integrator having a plurality of lens
 elements for forming a plurality of light source
 10 images, based on the beam from said light-source-image
 forming means, said lens elements having a rectangular
 cross section, two sides adjacent to each other of said
 rectangular cross section being different in length,
 said lens elements having a same refracting power both
 15 in the direction of the longer side of the rectangular
 cross section and in the direction of the shorter side
 thereof; and

a first relay optical system disposed between said
 light-source-image forming means and said optical
 20 integrator, for making a position of the light source
 images formed by said light-source-image forming means
 conjugate with a position of the light source images
 formed by said optical integrator,

said light supply means including;
 25 a light source system for emitting light
 having a beam cross section of substantially square or

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circle;

light source changing means for forming a plurality of light source images, based on the light from said light source system; and

5 a second relay optical system located between said light source changing means and said light-source-image forming means, for making a position of the light source images formed by said light source changing means conjugate with a position of the light source images formed by said light-source-image forming means.

2. An illumination optical apparatus comprising:

a light supply means for supplying a beam;

a light-source-image forming means for forming a plurality of light source images which are substantially linearly arranged in at least one line, based on the beam from said light supply means;

15 an internal reflection type integrator having two reflection planes parallel to each other for forming a plurality of light source images, based on the beam from said light-source-image forming means, said internal reflection type integrator having a rectangular cross section, two sides adjacent to each other of said rectangular cross section being different in length; and

25 a first relay optical system disposed between said light-source-image forming means and said internal

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reflection type integrator, for making a position of
the light source images formed by said light-source-
image forming means conjugate with a position of the
light source images formed by said internal reflection
type integrator,

said light supply means including;

a light source system for emitting light
having a beam cross section of substantially square or
circle;

light source changing means for forming a
plurality of light source images, based on the light
from said light source system; and

a second relay optical system located between
said light source changing means and said light-source-
image forming means, for making a position of the light
source images formed by said light source changing
means conjugate with a position of the light source
images formed by said light-source-image forming means.

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3. An illumination optical apparatus according to
claim 1, wherein said light-source-image forming means
is an optical integrator having a plurality of lens
elements arranged in at least one line, said lens
elements having a same refracting power both in the
direction in which said lens elements arranged and in
the direction perpendicular to the direction in which
said lens element arranged.

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4. An illumination optical apparatus according to claim 1, wherein the ratio of height to width of said optical integrator of said light-source-image forming means along a plane perpendicular to an optical axis of said apparatus is the same as the ratio of longitudinal and transverse length of each lens element of said optical integrator for forming light source images based on beam from said light-source-image forming means.

10 5. An illumination optical apparatus according to Claim 1, wherein said light source changing means is provided with a plurality of lens elements having a rectangular cross section.

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15 ⁸6. An illumination optical apparatus according to Claim 2, wherein said light source changing means is provided with a plurality of lens elements having a rectangular cross section.

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20 ⁷7. An illumination optical apparatus according to Claim 1, wherein said light source changing means is an internal reflection type integrator.

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⁸8. An illumination optical apparatus according to Claim 2, wherein said light source changing means is an internal reflection type integrator.

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25 ⁹9. An illumination optical apparatus comprising:
a light supply means for supplying a beam;
a light-source-image forming means for forming a

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plurality of light source images which are substantially linearly arranged in at least one line, based on the beam from said light supply means;

an optical integrator having a plurality of lens elements for forming a plurality of light source images, based on the beam from said light-source-image forming means, said lens elements having a rectangular cross section, two sides adjacent to each other of said rectangular cross section being different in length, said lens elements having a same refracting power both in the direction of the longer side of the rectangular cross section and in the direction of the shorter side thereof; and

a ~~first~~ relay optical system disposed between said light-source-image forming means and said optical integrator, for making a position of the light source images formed by said light-source-image forming means conjugate with a position of the light source images formed by said optical integrator,

said light supply means comprising:

a collector mirror having an ellipsoidal surface of revolution;

a light source located at one focal point of said ellipsoidal surface of revolution so that light emitted therefrom is reflected and collected by said collector mirror; and

a collimator lens for converting light collected by said collector mirror into substantially parallel beams⁴.

10. An illumination optical apparatus comprising;

a light supply means for supplying a beam;

a light-source-image forming means for forming a plurality of light source images which are substantially linearly arranged in at least one line, based on the beam from said light supply means;

an internal reflection type integrator having two reflection planes parallel to each other for forming a plurality of light source images, based on the beam from said light-source-image forming means, said internal reflection type integrator having a rectangular cross section, two sides adjacent to each other of said rectangular cross section being different in length; and

a ~~first~~ relay optical system disposed between said light-source-image forming means and said internal reflection type integrator, for making a position of the light source images formed by said light-source-image forming means conjugate with a position of the light source images formed by said internal reflection type integrator, wherein said light supply means comprising:

a collector mirror having an ellipsoidal surface

of revolution;

a light source located at one focal point of said ellipsoidal surface of revolution so that light emitted therefrom is reflected and collected by said collector mirror; and

a collimator lens for converting light collected by said collector mirror into substantially parallel beams^{1, 14}

11. An illumination optical apparatus comprising;

a light supply means for supplying a beam;

a light-source-image forming means for forming a plurality of light source images which are substantially lineally arranged in at least one line, based on the beam from said light supply means;

an optical integrator having a plurality of lens elements for forming a plurality of light source images, based on the beam from said light-source-image forming means, said lens elements having a rectangular cross section, two sides adjacent to each other of said rectangular cross section being different in length, said lens elements having a same refracting power both in the direction of the longer side of the rectangular cross section and in the direction of the shorter side thereof; and

a ~~first~~ relay optical system disposed between said light-source-image forming means and said optical

integrator, for making a position of the light source images formed by said light-source-image forming means conjugate with a position of the light source images formed by said optical integrator,

said light supply means comprising:

a collector mirror having an ellipsoidal surface of revolution; and

a light source located at a first focal point of said ellipsoidal surface of revolution so that light emitted therefrom is reflected and collected by said collector mirror.

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12. An illumination optical apparatus comprising;

a light supply means for supplying a beam;

a light-source-image forming means for forming a plurality of light source images which are substantially lineally arranged in at least one line, based on the beam from said light supply means;

an internal reflection type integrator having two reflection planes parallel to each other for forming a plurality of light source images, based on the beam from said light-source-image forming means, said internal reflection type integrator having a rectangular cross section, two sides adjacent to each other of said rectangular cross section being different in length; and

a ~~first~~ relay optical system disposed between said

light-source-image forming means and said internal reflection type integrator, for making a position of the light source images formed by said light-source-image forming means conjugate with a position of the light source images formed by said internal reflection type integrator,

said light supply means comprising:

a collector mirror having an ellipsoidal surface of revolution; and

a light source located at a first focal point of said ellipsoidal surface of revolution so that light emitted therefrom is reflected and collected by said collector mirror,

~~13. An illumination optical apparatus according to claim 12, wherein a correction optical system is provided so that it is set as coaxially with the optical axis of said collector mirror at a position between said collector mirror and a second focal point of said collector mirror, said correction optical system being arranged to form a real image of said light source.~~

14. An illumination optical apparatus according to Claim 12, wherein a correction optical system is provided so that it is set as coaxially with the optical axis of said collector mirror at a position between said collector mirror and a second focal point

of said collector mirror, said correction optical system being arranged to form a real image of said light source.

¹⁶ 13. A scanning exposure apparatus comprising:

5 a light supply means for supplying a beam;

a light-source-image forming means for forming a plurality of light source images which are sunstatially linerly arranged in at least one line, based on the beam from said light supply means;

10 an optical integrator having a plurality of lens elements for forming a plurality of light source images, based on the beam from said light-source-image forming means, said lens elements having a rectangular cross section, two sides adjacent to each other of said
15 rectangular cross section being different in length, said lens elements having a same refracting power both in the direction of the longer side of the rectangular cross section and in the direction of the shorter side thereof;

20 a first relay optical system disposed between said light-source-image forming means and said optical integrator, for making a position of the light source images formed by said light-source-image forming means conjugate with a position of the light source images
25 formed by said optical integrator;

a condenser optical system for condensing the beam

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from said optical integrator to illuminate a surface of a reticle;

a reticle stage for moving said reticle in a direction parallel to said surface of reticle;

5 a wafer stage for carrying a wafer on which integrated circuits are to be formed, and moving said wafer in a direction parallel to a surface of said wafer; and

10 a projection optical system disposed between said reticle and said wafer, for making a position at which said reticle is located conjugate with a position at which said wafer is located,

said light supply means including;

15 a light source system for emitting light having a beam cross section of substantially square or circle;

light source changing means for forming a plurality of light source images, based on the light from said light source system; and

20 a second relay optical system located between said light source changing means and said light-source-image forming means, for making a position of the light source images formed by said light source changing means conjugate with a position of the light source images formed by said light-source-image forming means.

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23 16. A scanning exposure apparatus comprising:

a light supply means for supplying a beam;

a light-source-image forming means for forming a plurality of light source images which are substantially and linearly arranged in at least one line, based on the beam from said light supply means;

an internal reflection type integrator having two reflection planes parallel to each other for forming a plurality of light source images, based on the beam from said light-source-image forming means, said internal reflection type integrator having a rectangular cross section, two sides adjacent to each other of said rectangular cross section being different in length;

a relay optical system disposed between said light-source-image forming means and said internal reflection type integrator, for making a position of the light source images formed by said light-source-image forming means conjugate with a position of the light source images formed by said internal reflection type integrator;

a condenser optical system for condensing the beam from said internal reflection type integrator to illuminate a surface of a reticle;

a reticle stage for moving said reticle in a direction parallel to said surface of reticle;

a wafer stage for carrying a wafer on which

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integrated circuits are to be formed, and moving said wafer in a direction parallel to a surface of said wafer; and

a projection optical system disposed between said reticle and said wafer, for making a position at which said reticle is located conjugate with a position at which said wafer is located,

said light supply means including;

a light source system for emitting light having a beam cross section of substantially square or circle;

light source changing means for forming a plurality of light source images, based on the light from said light source system; and

a second relay optical system located between said light source changing means and said light-source-image forming means, for making a position of the light source images formed by said light source changing means conjugate with a position of the light source images formed by said light-source-image forming means.

17. A scanning exposure apparatus according to claim ¹⁶ 15, wherein said reticle stage moves said reticle in a direction perpendicular to an optical axis of said apparatus and along a short side of a rectangular configuration of each lens element of said optical integrator, and said wafer stage moves said wafer in a

direction perpendicular to an optical axis of said apparatus and along a short side of a rectangular sectional configuration of each lens element of said optical integrator.

5 18.¹⁹ A scanning exposure apparatus according to claim 15,¹⁶

wherein said light-source-image forming means comprises an optical integrator having a plurality of lens elements arranged in at least one line.

10 19.²⁰ A scanning exposure apparatus according to claim 18,¹⁹

wherein the ratio of height to width of said optical integrator of said light-source-image forming means along a plane perpendicular to an optical axis of said optical integrator is proportional to the ratio of longitudinal and transverse length of each lens element of said optical integrator for forming light source images based on the beam from said light-source-image forming means.

20 20.²¹ A scanning exposure apparatus according to claim 19,²⁰

wherein said reticle stage moves said reticle in a direction perpendicular to an optical axis of said apparatus and along a short side of a rectangular configuration of each lens element of said optical integrator, and said wafer stage moves said wafer in a

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direction perpendicular to an optical axis of said apparatus and along a short side of a rectangular sectional configuration of each lens element of said optical integrator.

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